REMARKS

Claim Amendments

The change of "200 nm or less" to "a mean diameter of about 140nm (with a standard devitation of about 30nm)" in claims 1 and 3 refers to the EXAMPLE 1 in the present specification.

The addition of "…, wherein the ozone nano-bubbles with the mean diameter of about 140nm (with a standard devitation of about 30nm) are found to be stable in water after one week when the ozone water is placed in a glass bottle, and stored in a cool, dark place with the bottle being covered with a lid, and wherein the ozone concentration in the water has 1.0 mg/L or more in six months as the original ozone concentration has been about 1.5mg/L" to claims 1 and 3 refer to EXAMPLES of the present specification.

The change of "and adding" of claim 3 to "after the addition of" does not add new matter (Refer to page 10 line18 to page 11 line 6 of the our specification).

The additions of "electrolytes ions such as Na^+ and Mn^{2+}" and "of H^+ and OH^-" to claim 5 does not add new matter (Refer to page 11 line 7 to page 12 line 2 of the our specification).

The additions of ", whose electric conductivity is higher than 300 μ/cm," and ", and these concentrated ions due to the rapid bubble shrinkage reduce the solubility of gas molecules to the aqueous solution by the well-known effect of salting-out" to claim 7 does not add new matter (Refer to page 10 line 18 to page 12 line 2 of the our specification).

Claims 2 and 6 are canceled.

Claim Rejections – 35 USC § 103

Comparison between the present invention and the cited references:

The present invention is based on the Applicants' study of microbubble lasting for 20 years or more. The Applicants have acquired the background knowledge regarding the present invention from the study of microbubbles:

a) the microbubble is a bubble having a diameter of 10-50 μm and disappears in water (This is because an internal gas is effectively dissolved.);

b) the microbubble takes electrical charge caused by the adsorbed ions at the gas-water

interface of the tiny bubble, and the adsorbed ions are H^+ and OH^- generated by the electrolytic dissociation of water; and

c) the charge increases by the shrinking process of the microbubble under water; and

d) the increase ratio of the bubble charge is proportional to the shrinking speed of the microbubble ; and

e) the charged surface of the microbubble attracts the counter ions including the electrolyte ions such as Na^+ and Mn^{2+}, and these ions suppress the dissolution of the interior gas of the shrinking microbubble.

Furthermore, the Applicants found the knowledge leading to the present invention:

f) the generated nanobubble from the shrinking microbubble by accelerating the shrinking speed using the physical stimulation has been covered by the condensed electrolyte ions;

g) when the bubble has been shrunk to about 140nm in diameter, the bubble stabilizes for long period under water with longevity for six months.

The present invention has disclosed the generating method of the nanobubble with long life time according to the accumulation of counter ions around the gas-water interface due to the acceleration of the shrinking speed of the previously generated microbubbles by the physical stimulations. Since the tiny bubbles tend to be dissolved at once because of the pressurized interior gas due to the surface tension, we need some special method to stabilize the tiny bubble. Our invention is depending on the above mentioned knowledge a)-g). The accumulated counter ions around the gas-water interface suppress the dispersion of interior gas to the surrounding water owing to the well-known salting out effect, and the bubbles (nanobubbles) can be stable for long duration. Another important property of the present invention is regarding to the stabilized aqueous ozone with long life time. The rapid shrinkage of microbubble by the physical stimulation provides the accumulation of counter ions around the gas-water interface, and the compressed interior ozone by the gas-water interface of the shrinking microbubble strongly oxidizes some of the closely located counter ions. Mn^{2+} is one of the counter ions that is preliminary oxidized to Mn(+VII), and the super oxidized ions around the nanobubble contribute to stabilize the interior ozone.

On the other hand, all of the inventions in seven cited references (WO03/0227356, JP2002-307053, JP60-122337, Bunkin et al., McGrath et al., Aquarius, and Didenko), which the examiner cites, disclose the method to generate the minute bubbles immediately. According to our knowledge it is impossible to stabilize a directly generated nanobubble at the water condition as described in the present invention. So the cited invention is completely different form the present invention. Under the water condition the nano sized bubble disappears within one second.

WO03/0227356 disclosed how to generate the highly concentrated ozone water by an electrical discharge with the existence of the gas phase as the form of fine bubble in the discharge area. Oxygen gas is changed to ozone gas by the discharge. Since after the discharge the ozone remover removes the ozone gas, the fine bubble (gas phase) cannot exist in the water. So the invention of WO03/0227356 is not related to the present invention that discloses how to generate the long life-time nanobubbles.

JP2002-307053 disclosed how to collapse the bubble by ultrasound. JP2002-307053 doesn't disclose how to generate the long life-time nanobubble.

JP60-122337 disclosed how to generate the high ozone concentration by using turbulent flow. It means that the turbulent flow is used to collapse the tiny bubbles, not to prolong the life-time of the bubble.

Didenko disclosed the sonoluminescence of water by the emission from C_2. Sonoluminescence is created by the bubble collapse and the extreme high temperature as the result of adiabatic compression. This is not related to the long life nanobubble.

Bunkin et al. disclosed that bubstons could be work as bubble nuclei for the optical cavitation. Bubble nuclei easily expand to the macroscopic bubbles according to the change in environmental condition. These bubbles cannot exist for long duration as tiny bubbles.

McGrath et al disclosed that oxygen nanobubbles as small as 20-30 nm can supply the oxygen concentration significantly higher than 250 ppm to tissues, and they form irregular networks that nearly completely cover hydrophobic surfaces. Since the high oxygen concentration of dissolved gas must be derived from the nanobubble, these nanobubbles have short life-time. The nanobubbles are not same as that of the present invention.

Ozone nanobubble of the present invention is stable for more than six months. The tiny bubble with long life time doesn't become the supply medium of the dissolved gas in water. Therefore, the dissolved gas is not supersaturated in the present invention.

Conclusion

The structure, effect and purpose of the present invention are different from seven references that the examiner cites. Moreover, the present invention is not a thing that combines seven references that the examiner cites.

Therefore, one skilled in the art would not be drawn to combine those references in order to produce the claimed invention.

The Applicants respectfully request that the rejection of obviousness be withdrawn for all the claims.

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The Commissioner is authorized to charge any additional fees which may be required or credit overpayment to deposit account no. 12-0415. In particular, if this response is not timely filed, the Commissioner is authorized to treat this response as including a petition to extend the time period pursuant to 37 CFR 1.136(a) requesting an extension of time of the number of months necessary to make this response timely filed and the petition fee due in connection therewith may be charged to deposit account no. 12-0415.

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